Available online at www.sciencedirect.com

SCIENCE DIRECT

Preventive Medicine 40 (2005) 355–362

Preventive Medicine

www.elsevier.com/locate/ypmed

Community level alcohol availability and enforcement of possession laws as predictors of youth drinking

Clyde W. Dent, Ph.D.[a,*], Joel W. Grube, Ph.D.[b], Anthony Biglan, Ph.D.[a]

[a] Oregon Research Institute, Eugene, OR, USA
[b] Prevention Research Center, Pacific Institute for Research and Evaluation, Berkeley, CA, USA

Available online 27 July 2004

Abstract

Background. Despite a minimum legal drinking age, many young people use alcohol. Environmental strategies to control youth drinking focus on restricting access and the enforcement of possession laws. This study examines the relationship between use of these strategies and the frequency of youth alcohol use and related problems.

Methods. Participants were 16,694 students, ages 16–17 in 92 communities in Oregon. A multi-level analysis of a repeated cross-sectional statewide student survey was conducted. The outcome measures examined include 30-day frequency of alcohol use, binge drinking, use of alcohol at school, and drinking and driving.

Results. The rate of illegal merchant sales in the communities directly related to all four alcohol-use outcomes. There was also evidence that communities with higher minor in possession law enforcement had lower rates of alcohol use and binge drinking. The use of various sources in a community expanded and contracted somewhat depending on levels of access and enforcement.

Conclusions. This evidence provides empirical support for the potential utility of local efforts to maintain or increase alcohol access control and possession enforcement.

Keywords: Adolescent; Alcohol drinking; Social control

Introduction

Despite nationwide adoption of a 21-year-old minimum legal drinking age, national surveys consistently indicate that young people use alcohol frequently. For example, the 2002 Monitoring the Future (MTF) survey reveals that, by their senior year in high school, 78% of adolescents reported having experimented with alcohol, 49% report drinking within the previous month, 30% report being intoxicated during the previous month, and 29% report heavy episodic drinking (having five or more drinks in a row) during the past 2 weeks [1]. Adolescent alcohol use, and especially heavy episodic drinking, is related to a wide variety of problem behaviors including drinking and driving, fighting, truancy, theft, assault, and precocious and risky sexual activities [2–5]. In addition to the immediate costs of underage drinking, early initiation to drinking may also be associated with other adverse outcomes, including increased risk for the development of alcohol abuse and dependence later in life [6].

Young people secure alcohol from a variety of commercial and social sources. Research indicates that while parties, friends, and adult purchasers are the most common sources of alcohol among adolescents [7–10], commercial outlets are also used. Purchase surveys reveal that anywhere from 30% to 90% of outlets will sell alcohol to underage or apparent underage buyers, depending upon their geographical location [8,11–15].

Traditionally, adolescent drinking and drinking problem prevention strategies have relied on programs that attempt to reduce demand by providing new information, teaching new skills, or countering erroneous normative beliefs [16,17]. Demand reduction programs, however, cannot provide a complete answer to the problem of drinking by young people, as evidenced by their somewhat limited success in reducing alcohol use [18–21]. In part, this limitation arises because young people are immersed in a broader social context in which alcohol is readily available and glamorized [22].

* Corresponding author. In Care of: Christine Cody, Oregon Research Institute, 1715 Franklin Boulevard, Eugene, OR 97403-1983. Fax: +1-541-484-1108.
E-mail address: cdent@ori.org (C.W. Dent).

0091-7435/$ - see front matter © 2004 The Institute For Cancer Prevention and Elsevier Inc. All rights reserved.
doi:10.1016/j.ypmed.2004.06.014

In contrast to demand reduction approaches, environmental strategies focus on policy, legal/regulatory changes, and enforcement [22,23]. Many environmental interventions directly target the availability of alcohol to underage drinkers by increasing personal or economic costs associated with providing it. Research shows that even moderate increases in enforcement can reduce sales of alcohol to minors by as much as 35% to 40%, especially when combined with strategic media advocacy and other community and policy activities [13,24].

Although community-level restrictions on alcohol availability to youth and increased enforcement of minor possession laws are becoming increasingly important as local intervention strategies, [25] few studies have investigated the effects of alcohol availability and possession enforcement at the local level on consumption by young people [21,22]. As a result, little is known about how increased enforcement and resulting changes in local availability of alcohol are related to reductions in alcohol use and alcohol-related problems among young people. Measures of availability of alcohol have been found to predict drinking and related problems in adults [26–28]. More recently, alcohol outlet density has been related to ease of underage purchase of alcohol [29] and to frequency of underage drinking and driving and riding with drinking drivers [30]. In one experimental study addressing changes in availability on youth drinking [24], it was found that while a comprehensive environmentally focused program, which included enforcement of sales laws as one of several components, led to increases in checking age identification by alcohol merchants and reduced sales to minors, it had no observed effects on drinking by high school students. In part, this absence of effects may have resulted from a lack of statistical power because of the relative small number of communities in the study (N = 15). This pattern of findings may also have resulted because adolescents often obtain alcohol from a variety of non-commercial sources that may not have been affected by the program.

In the current study, we examine the strength and variations in the relationship of social and commercial alcohol access sources to youth drinking in a population-based survey conducted in 93 communities. We further investigate the community level variations in the use of these sources as a function of community level indictors of local commercial availability and enforcement of minor in possession (MIP) laws.

Method

Design and participants

Oregon Healthy Teens (OHT) is an ongoing survey-based study of adolescent health behaviors and their influences. We have identified and recruited a population-based sample of communities in Oregon for participation in the study. The primary sampling unit for the study was the community defined by the catchment area of a high school and the middle, junior, or elementary schools that feed into them. We randomly sampled, proportional to size, 115 such communities and successfully recruited the schools in 93 of them (81%) to participate.

The same schools, but different birth cohorts, are assessed in the spring of each year. We attempt to survey all of the 8th and 11th grade students in these communities annually using local Institutional Review Board approved procedures. Approximately 4 weeks before survey administration, parent notification letters were mailed to the students' home, with instructions to notify the school if they wished their child not to participate. Research staff administer anonymous student questionnaires in classrooms during regular school periods, and students are instructed that their participation is voluntary.

For the present report, we analyzed data from the 11th grade students collected during the spring of 2001 and 2002. The median 11th grade enrollment in the communities was 156 students (range = 25 to 585). Parents of 5% of the enrolled students wished their child not to participate, and an additional 2% of the enrolled students chose not to participate. In addition, another 14% of the students listed on the class rosters were not present on the day of the survey, bringing the student participation rate to 79%. The student participation rates did not vary systematically across communities.

There were 16,694 11th grade student surveys collected overall, with 7,486 (45%) collected in 2001 and 9,208 (55%) were collected in 2002. Three percent of the students were Native American, 4% were Asian, 1% were Hawaiian or Pacific Islanders, 2% were African American, 8% were Hispanic, and 85% were White, non-Hispanic. Fifty percent of the sample was female.

Measures

The OHT questionnaire consists of a demographics section that is completed by all students and a set of six modules ordered into sets of three so that any given student completes a randomly chosen set of three. This allowed the collection of data on a wide range of aspects of adolescent well-being as well as data on risk and protective factors. Approximately 50% of the students in a given classroom received any given survey module, and approximately 20% received any given pair of modules.

Alcohol use

The primary outcome variables used in this analysis are student alcohol use in the last 30 days. Estimates of frequency of alcohol use were derived from students' answers to the question, "During the PAST 30 DAYS, on how many days did you have at least one drink of alcohol?" with choices: 0 days, 1 or 2 days, 3 to 5 days, 6 to 9 days, 10 to 19 days, 20 to 29 days, and all 30 days.

Heavy episodic or "binge" drinking (excessive quantity of drinking) was assessed with the question, "During the PAST 30 DAYS, on how many days did you have five or more drinks of alcohol in a row, that is, within a couple of hours?" The response choices were: 0 days, 1 day, 2 days, 3 to 5 days, 6 to 9 days, 10 to 19 days, and 20 or more days.

Alcohol use at school was measured by the question "During the PAST 30 DAYS, on how many days did you have at least one drink of alcohol on school property?" with the same response choices as for the binge drinking question.

Drinking and driving/riding (DUI) was measured by the items "During the past 30 days, how many times did you . . ." "Drive a car or other vehicle when you had been drinking alcohol?" and "Ride in a car of other vehicle with a teenage driver who had been drinking alcohol?" Responses were "0 times," "1 time," "2 or 3 times," "4 or 5 times," and "6 or more times." For the purposes of analysis, these two items were summed.

All these items are derived from the CDC Youth Risk Behavior Survey [31].

Sources of alcohol

On a separate module, students reported where they obtained alcohol: "During the past 30 days, how many times did you get alcohol (beer, wine, or hard liquor) from each of the following sources. . ." The questionnaire included 8 possible sources, as indicated in Fig. 1. These sources included both commercial and social sources. Students indicated their use of each source on an 8-point scale (none, 1, 2, 3, 4, 5–9, 10–14, 15 or more). For the purposes of analysis, a 'commercial source' variable was formed as the sum of grocery stores, convenience stores, drug stores, and gas stations.

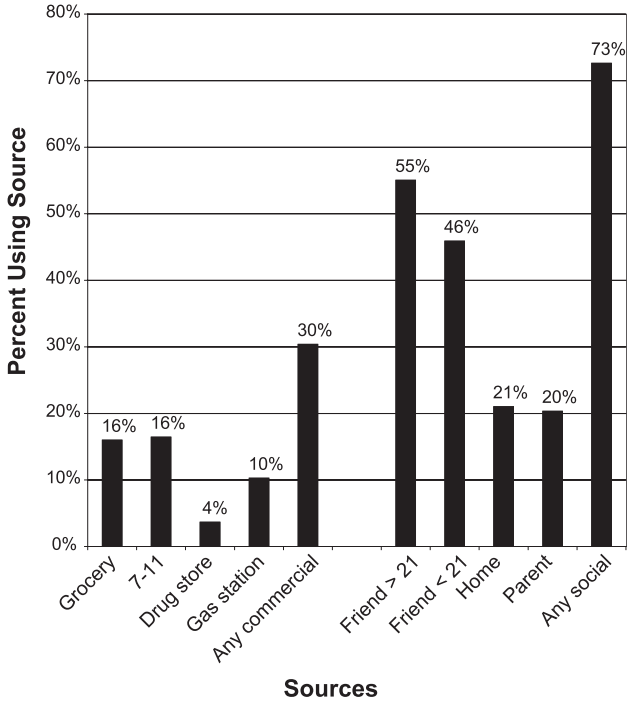

Fig. 1. Source of alcohol among 30-day users (Oregon 2001–2002).

Community level indicators

As a community index of commercial alcohol availability, we calculated the percent of students in each community that reported using any of the four commercial sources above. As a community index of enforcement of minor in possession (MIP) laws, we computed the mean in each community on the following item, "If a kid drank some beer, wine, or hard liquor in your neighborhood, would he or she be caught by the police?" The 4-point response scale was "NO! (definitely not true)", "no (mostly not true)", "yes (mostly true)" and "YES! (definitely true)".

Analysis

We used a multilevel modeling approach to examine the relationship of both individual level and community level access measures to youthful alcohol use. Conceptually, the model evaluates the effect of both individual level (Level 1) and community level (Level 2) variables by simultaneously estimating three combined regression equations. At level 1, an alcohol use variable, Y_{ij}, of individual student i residing in community j is predicted by the equation:

$$Y_{ij} = \beta_{0j} + \beta_{lj}(X_{lij}) + r_{ij},$$

where values of β_{0j} and β_{1j} are allowed to vary across the j communities such that the intercept term β_{0j} represents the mean level of alcohol use in each community; and the β_{lj} represent the relative use in each community of the ($l = 1$ to 5) commercial or social source predictors, X_{lji}. The term r_{ij} is the level 1 random error term.

While the individual-level analysis estimates can be of substantive interest in and of themselves, the extent to which there is variability of these estimates across communities, and the extent to which that variability can be explained as a function of the community level (Level 2) variables of commercial access rates and MIP enforcement is the primary analytical goal here.

At Level 2, each community's alcohol use mean (β_{0j}) and source slopes (β_{lj}) are modeled as a function of level 2 variables:

$$\beta_{0j} = \gamma_{00} + \gamma_{0w}(W_{0j}) + \gamma_{0z}(Year) + u_{0j},$$

and $$\beta_{lj} = \gamma_{l0} + \gamma_{lw}(W_{lj}) + u_{lj},$$

where γ_{00} is the average intercept (average level of alcohol use frequency) across communities, and the γ_{l0} are the average slopes (average relative use) of each of the

sources, $\beta_{lj,}$ across communities. W_j are level 2 predictors, in this case, the estimated youth commercial access rate and level of MIP enforcement in each community; γ_{0z} represents the secular rise or fall in 11th grade alcohol use over the two measurement time points (years), and u_{0j} and u_{lj} are the level 2 random error terms. The term γ_{0w} represents the *direct* or main effect of community-level access rates and MIP enforcement on mean levels of youth alcohol use. The terms γ_{lw} estimate the *cross-level* or interactional effects of community access rates or MIP enforcement and the use of each of the $l = 1$ to 5 examined sources of alcohol. That is, they estimate the degree to which the relative use of a source, as it relates to the frequency of alcohol use, varies as a function of rate of illegal sales or MIP enforcement in the community.

We performed computations using SAS Proc Mixed [32], which provides a general linear mixed model capability. It has also shown to provide accurate estimates even when the dependent variables are non-normally distributed [33].

We centered the source predictor variables around the around the group (community) means. Group-mean centering compares each score relative to the mean for its particular group. For example, with group centering, the value for a student's use of commercial sources is the number of times they used them more often or less often that the average number of times they were used by all students in their community. We standardized the scale of the outcome and community level variables so that their standard deviations were equal to one. The original scale (number of days) standard deviations for the outcomes are: frequency of alcohol use last 30 days, 1.030; frequency of binge drinking last 30 days, 1.141; frequency of alcohol use at school last 30 days, 0.372; and frequency of DUI in last 30 days, 1.101. Community level access rates (CAR) have a standard deviation of 4.791%; and the 4-point perception of enforcement of MIP laws scale has a standard deviation of 0.151. Year was effect coded (−1, 1). Sampling weights were used in all calculations.

Results

Sources of alcohol

Fig. 1 presents data on the percent of *current drinkers* who reported obtaining alcohol from each of eight sources, as well as for any commercial and any social source. Overall, commercial sources were used by 30% of current drinkers, while social sources were used by over 70%.

The upper portions of Tables 1–4 present the individual level coefficients for relative use of sources to predict the alcohol-use frequency outcomes. These coefficients represent the average use of the sources across the population. The scale on these predictors was centered but left at number of times a source was used. Because the alcohol outcome variables were standardized, coefficients represent standard deviation unit changes in the outcomes for each additional time a source was used, controlling for the use of other sources. Source coefficients presented in this way are directly comparable across sources and outcomes. Translation of the source coefficients to raw scale outcome units (days) can be achieved by multiplying the tabled coefficients by the standard deviation of the specific outcome. For example, in Table 1, the standardized coefficient for use of a commercial source is 0.041. The standard deviation for 30-day alcohol use is 1.030 (days), so the coefficient in days per time used is 0.041 × 1.030 = 0.042. In either the standardized or raw scale, positive coefficients indicate relatively increased alcohol use with use of that particular source, whereas negative coefficients indicate that use of a source is associated with relatively less alcohol use.

Table 1
Results from multi-level modeling for 11th grade: frequency of alcohol use last 30 days

Fixed effect	Coefficient	se	*t* Ratio
Model for individuals (N = 3318)			
Commercial sources	0.041	0.006	6.84***
Friends > 21 source	0.175	0.007	24.71***
Friends < 21 source	0.059	0.010	5.51***
Parent source	0.075	0.016	4.49***
Stole from home source	−0.016	0.015	−1.06
Model for communities (N = 93)			
Commercial access rate (CAR)	0.054	0.025	2.15**
Minor in possession enforcement (MIP)	−0.040	0.021	−1.96**
Cross-level effects			
CAR→Commercial source	0.013	0.006	1.96**
CAR→Friend > 21 source	−0.005	0.006	−0.88
CAR→Friend < 21 source	0.026	0.010	2.46***
CAR→Parent source	0.058	0.017	3.28***
CAR→Home source	0.019	0.016	1.19
MIP→Commercial source	−0.004	0.006	−0.70
MIP→Friend > 21 source	0.011	0.007	1.38
MIP→Friend < 21 source	−0.021	0.011	−1.87*
MIP→Parent source	−0.025	0.016	−1.56
MIP→Home source	0.059	0.018	3.29***

*$p < .10$, ** $p < .05$, *** $p < .01$. Alcohol use, CAR and MIP variables are standardized to a variance of 1.0; source units are number of times used last 30 days.

Provision of alcohol by friends over 21 was the largest contributor to frequency of alcohol use outcomes (range 0.129 to 0.187) for all but use at school, followed by provision of alcohol by friend under 21 (range 0.059 to 0.100). Parent sources contributed positively to general frequency of use (0.075), but negatively to frequency of binge drinking (−0.055) and driving/riding while drinking (−0.082). Taking from home without permission was associated only with frequency of drinking at school (0.113). Use of commercial sources independently contributed significantly and positively to each of the alcohol use outcomes examined (range 0.041 to 0.108). The estimates

Table 2
Results from multi-level modeling for 11th grade: frequency of binge drinking last 30 days

Fixed effect	Coefficient	se	*t* Ratio
Model for individuals (N = 3318)			
Commercial sources	0.061	0.005	10.52***
Friends > 21 source	0.187	0.006	27.53***
Friends < 21 source	0.070	0.010	6.90***
Parent source	−0.055	0.016	−3.42***
Stole from home source	0.010	0.015	0.69
Model for communities (N = 93)			
Commercial access rate (CAR)	0.060	0.024	2.46***
Minor in possession enforcement (MIP)	−0.035	0.020	−1.68*
Cross-level effects			
CAR→ commercial source	0.021	0.006	3.43***
CAR →Friend > 21 source	−0.016	0.006	−2.59***
CAR→Friend < 21 source	0.030	0.010	2.97***
CAR→Parent source	0.088	0.017	5.21***
CAR→Home source	−0.000	0.015	−0.00
MIP→Commercial source	0.001	0.006	0.18
MIP→Friend > 21 source	−0.002	0.007	−0.37
MIP→Friend < 21 source	−0.033	0.011	−3.05***
MIP→ Parent source	0.020	0.015	1.34
MIP→ Home source	0.030	0.017	1.80*

*$p < .10$, ** $p < .05$, *** $p < .01$. Binge drinking, CAR and MIP variables are standardized to a variance of 1.0; source units are number of times used last 30 days.

for variance components (not shown) indicated that the relationship of sources to outcomes varied significantly across communities.

Prediction of community-level alcohol use from access and enforcement

The middle sections of Tables 1–4 show the coefficients for the models for community predictors. They indicate that higher rates of community level commercial access, as indexed by the percentage of students in the community that reported buying, were significantly and positively related to the mean levels of alcohol use and related problems in those communities (range 0.054 to 0.078). Stronger enforcement of minor in possession laws, as indexed by the student's average perceived level of enforcement in the community, was significantly related to lower levels in the communities' general frequency of use and binge drinking (−0.040 and −0.035, respectively), but not levels of drinking in school or drinking and driving/riding.

Because both the outcomes and the community level variables are standardized, the tabled coefficients indicate standard deviation changes in outcomes for each standard deviation increase in the community level predictors and are directly comparable across outcomes and to each other (but not to the individual level coefficients). Translation of the standardized coefficients into raw scale units is achieved by multiplying by the ratio of the outcome to predictor standard deviations. For example, in Table 1, the standardized CAR coefficient predicting 30-day alcohol use is 0.054. The standard deviation of alcohol use is 1.030 (days) and 4.791 (percent) for CAR. The raw scale coefficient is then 0.054 (1.030/4.791) = 0.012 days increase in 30-day drinking for each 1% increase in community access rate. Similarly, the standardized coefficient for MIP in Table 1 is −0.040 and its standard deviation is 0.151, so the raw scale coefficient is −0.040 (1.030/0.151) = −0.272 days reduction in moving, for example, from "no" to "yes" on the MIP scale.

We also tested the interaction between the two community level variables, that is, whether increased MIP enforcement in combination with higher or lower commercial access had a differential impact than expected from each additively, and found none to be significant.

Impact of community-level access and enforcement on source use

The lower sections of Tables 1–4 show the coefficients for cross-level effects. Community level commercial access interacted with the individual's use of sources such that communities with overall higher commercial access had more frequent use of those sources for general alcohol use and binge drinking (0.013 and 0.021, respectively), and *less* frequent use of those sources for alcohol use in school and when drinking and driving/riding (−0.043 and −0.027, respectively). Regarding the impact on friends as a social source, communities with higher levels of commercial access have slightly less dependence on sources over 21

Table 3
Results from multi-level modeling for 11th grade: frequency of drinking at school last 30 days

Fixed effect	Coefficient	se	*t* Ratio
Model for individuals (N = 3318)			
Commercial sources	0.108	0.007	13.70***
Friends > 21 source	0.012	0.009	1.34
Friends < 21 source	0.004	0.013	0.32
Parent source	0.018	0.022	0.82
Stole from home source	0.113	0.020	5.46***
Model for communities (N = 93)			
Commercial access rate (CAR)	0.058	0.025	2.28***
Minor in possession enforcement (MIP)	−0.023	0.022	−1.05
Cross-level effects			
CAR→Commercial source	−0.043	0.008	−5.03***
CAR→Friend > 21 source	0.009	0.008	1.12
CAR→Friend < 21 source	−0.000	0.014	−0.06
CAR→Parent source	0.059	0.023	2.53***
CAR→Home source	0.036	0.021	1.74*
MIP→Commercial source	−0.019	0.008	−2.29***
MIP→Friend > 21 source	−0.049	0.010	−4.83***
MIP→Friend < 21 source	0.021	0.015	1.45
MIP→Parent source	−0.021	0.021	−1.00
MIP→Home source	−0.021	0.023	−0.94

*$p < .10$, **$p < .05$, *** $p < .01$. Drinking at school, CAR and MIP variables are standardized to a variance of 1.0; source units are number of times used last 30 days.

Table 4
Results from multi-level modeling for 11th grade: frequency of drinking and driving/riding last 30 days

Fixed effect	Coefficient	se	*t* Ratio
Model for individuals (N = 3073)			
Commercial sources	0.056	0.006	8.81***
Friends > 21 source	0.129	0.008	14.63***
Friends < 21 source	0.100	0.013	7.40***
Parent source	−0.082	0.016	−5.03***
Stole from home source	−0.005	0.015	−0.34
Model for communities (N = 93)			
Commercial access rate (CAR)	0.078	0.024	3.19***
Minor in possession enforcement (MIP)	0.032	0.021	1.49
Cross-level effects			
CAR→Commercial source	−0.027	0.006	−4.06***
CAR→Friend > 21 source	0.044	0.008	5.09***
CAR→Friend < 21 source	−0.084	0.013	−6.50***
CAR→Parent source	0.030	0.016	1.79*
CAR→Home source	0.057	0.016	3.47***
MIP→Commercial source	−0.036	0.005	−6.22***
MIP→Friend > 21 source	0.056	0.008	6.68***
MIP→Friend < 21 source	−0.022	0.014	−1.52
MIP→Parent source	−0.041	0.018	−2.25***
MIP→Home source	−0.017	0.016	−1.10

*$p < .10$, ** $p < .05$, *** $p < .01$. Drinking and driving/riding, CAR and MIP variables are standardized to a variance of 1.0; source units are number of times used last 30 days.

(−0.016) for binge drinking but more dependence on that source while drinking and driving/riding (0.044); and more use of sources under 21 for binge drinking (0.030) and in general (0.026) but less use of those under 21 while driving (−0.084). Communities with higher commercial access also had higher provision of alcohol by parents for all outcomes but drinking and driving (0.058 to 0.088); and taking from home without permission was used more often in high access communities for use in school (0.036) or drinking and driving (0.057).

Community level enforcement of minor in possession laws was a deterrent for individual's use of commercial sources to drink in school (−0.019) or to drink and drive (−0.036). It also deterred the use of friends under 21 for binge drinking (−0.033) and use in general (−0.021) and the use of parent sources for drinking and driving (−0.041). On the other hand, communities with higher MIP enforcement also tended to have more reliance on taking from home without permission for binge drinking (0.0303) and use in general (0.059), and for more frequent use of friends over 21 as a source while driving (0.056).

One may meaningfully interpret the cross-level interaction coefficients in the models as the amount one must add to the source coefficients for each unit change in the community level variable. Again, because the outcome and community variables were standardized, these coefficients are in standard deviation units and are comparable across outcomes and community level variables. As with the community-level direct effect coefficients, translation of the cross-level coefficients to the original scales is achieved by multiplying by the ratio of the outcome to community predictor standard deviations.

Discussion

Of primary substantive interest in this analysis was the relationship of the community level variables of access and enforcement on the communities' mean level of alcohol use and related problems. Using a relatively large number of communities ($N = 93$), the results above provide evidence for the direct impact of these community level predictors on a range of youth alcohol-related outcomes. This evidence provides much needed empirical support for the potential utility of increasing access control and possession enforcement as recommend by the Office of Juvenile Justice and Delinquency Prevention "Best Practices" [25].

Regarding commercial access, the results indicated a consistent pattern on both the independent use of those sources by individual adolescents and the association between rates of youth access and alcohol problems in the community. The independent contribution of commercial sources to the general frequency of drinking is troubling, but the evidence for use of these sources for excessive (binge) drinking and drinking in very inappropriate contexts (school and driving) at the individual and local community level raises the level of concern. Increased efforts to reduce youth commercial access to alcohol, including merchant education and surveillance programs, may well serve local public health and law enforcement officials in reducing these problems in their communities.

Community levels of commercial access also were seen to modify (interact with) the frequency of use of social sources of alcohol in a somewhat complex fashion. This may occur because, as access to one source (commercial) becomes more difficult, resourceful adolescents modify their alcohol-seeking behavior to compensate and/or may simply use a larger number of alternative sources. For example, we found that for general alcohol use and binge drinking frequency, those communities with higher access rates also had adolescents who used friends under 21 and parent sources more often, in addition to the increased use of commercial sources. The increased use of friends under 21 certainly could be the indirect result of more of youth suppliers who themselves obtained the alcohol from commercial sources. The increased reliance on parent sources, however, may reflect a community wide tolerance for adolescent drinking, as evidenced by both commercial availability and adult provision of alcohol. A similar explanation may underlie the finding of increased use of parent sources for use in school, and the provision of alcohol by adults (friends over 21) while drinking and driving or riding in communities with higher commercial access rates.

Regarding enforcement of minor in possession laws, we found that communities with increase levels of enforcement

tended to have lower community levels of binge drinking and drinking in general. These effects are consistent with the notion that perceived negative consequences (being caught by the police), if broad and severe enough, could be a deterrent to behavior. The effect on in-school drinking and on drinking and driving/riding was not reliable. The lack of associations on those outcomes may have been due to the literal interpretation of the item, which referred to being caught if used in the neighborhood. Youth may have interpreted that not to mean while at school or in a car. Alternatively, community-level police enforcement may simply be unassociated with, or perceived as highly unlikely, in these alcohol use contexts.

Enforcement interacted with source usage. Use of sources under the age of 21 for binge drinking and general alcohol use was curtailed in communities with high enforcement, as could be expected when possession by those under 21 is restricted. Use of commercial sources was also curtailed in communities with high MIP enforcement for in school and drinking while driving. In the case of in-school use, this interaction brings the impact of MIP enforcement to a significant level overall (−0.042), in communities with high access. However, in the case of drinking and driving, the overall effect of MIP enforcement is still near zero (−0.004) in communities with high access. Higher MIP enforcement in the community does appear to increase the use of taking from home without permission for binge and general drinking, perhaps because youth simply drink at home if they feel they would be caught outside the home. The negative interaction between use of parent sources (with or without permission) for drinking and driving does appear to be reduced in stricter MIP-enforced communities below already infrequent overall levels, perhaps because of the wider message it sends parents regarding the unacceptability of provision of alcohol to their children, especially if they are going to be involved with vehicles. The same does not appear to be true for friends over 21, however, as evidenced by the positive interaction term for that effect.

Limitations

While the results presented here provide evidence for the statistical association between youth drinking and commercial access and possession enforcement, the magnitude of the public health impact is somewhat difficult to judge here. The total impact in the days per month, on average, that a community would experience for a given increase or decrease in access and/or enforcement can be calculated from these models days as the sum of the direct and interactional raw scale coefficients. For example, each 10% rise or fall in commercial access rates in a community is predicted to result in a change in the community average for number of days per month driving or riding while drinking by 0.225. However, the costs for achieving a 10% reduction in access rates, as well as the actual societal benefits for reducing youthful DUI by 0.225 days in a community, are beyond the scope of these data.

Several other aspects of the study are limiting. First, our data are epidemiological in nature, being observations of natural occurring variations in individuals and communities, and as such our conclusions are limited to observed associations at levels of the examined variables. Experimental manipulation of community access and enforcement is needed to draw casual inference on the relationship between access, enforcement, and levels of youthful alcohol use. However, the presence of associations across a large number of communities and outcomes strengthens our confidence in these findings. Second, we use aggregate student self-report measures of community level access and enforcement. It is certainly possible that different associations and conclusions would be drawn from access measures such as alcohol outlet density, minor decoy purchase survey rates, or enforcement measures such as number of officers assigned or citations issued, etc. We feel our community level measures do have meaningful direct interpretation, and provide at least a proxy for the level of youth access and MIP enforcement in a community. Third, the results presented are overall averages of relationships and as such may not reflect the processes in any given community. However, they do provide an overall pattern of results that may be appropriate for statewide policy decisions. Finally, our results are limited to a narrow age range (16–17 year old) of in-school youth and of fairly homogeneous ethnic makeup (85% White) in a sample of largely rural northwestern US communities. The impact of access and enforcement in other youth populations may vary as a function of age and region. Again, however, the large number of communities examined, and the manner in which they were chosen, provides confidence that similar results would be obtained in similarly composed communities elsewhere.

Acknowledgments

Dr. Dent and Dr. Biglan were supported in part by NCI grant CA86169. Dr. Grube was supported in part by NIAAA grant AA06282.

References

[1] Johnston LD, O'Malley PM, Bachman JG. Monitoring the Future national results on adolescent drug use: Overview of key findings, 2002. (NIH Pub. No. 03-5374). Bethesda, MD: National Institute on Drug Abuse. Available online at: http://www.monitoringthefuture.org/pubs/monographs/overview2002.pdf.

[2] Fergusson DM, Lynskey MT. Alcohol misuse and adolescent sexual behaviors and risk taking. Pediatrics 1996;98:91–6.

[3] Fergusson DM, Lynskey MT, Horwood LJ. Alcohol misuse and juvenile offending in adolescence. Addiction 1996;91:483–94.

[4] Levy DT, Miller TR, Cox KC. Costs of underage drinking. Calverton, MD: OJJDP Center for Enforcing Underage Drinking Laws. Available online at: http://www.udetc.org/documents/costunderagedrinking.pdf.

[5] Wechsler H, Molnar BE, Davenport AE, Baer JS. College alcohol use: a full or empty glass? J Am Coll Health 1999;47:247–52.
[6] Grant BF, Dawson DA. Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. J Subst Abuse 1997; 9:103–10.
[7] Harrison PA, Fulkerson JA, Park E. Relative importance of social versus commercial sources in youth access to tobacco, alcohol, and other drugs. Prev Med 2000;31:39–48.
[8] Preusser DF, Williams AF. Sales of alcohol to underage purchasers in three New York counties and Washington DC. J Public Health Policy 1992;13:306–17.
[9] Schwartz RH, Farrow JA, Banks B, Giesel AE. Use of false ID cards and other deceptive methods to purchase alcoholic beverages during high school. J Addict Dis 1998;17:25–34.
[10] Wagenaar AC, Toomey TL, Murray DM, Short BJ, Wolfson M, Jones-Webb R. Sources of alcohol for underage drinkers. J Stud Alcohol 1996;57:325–33.
[11] Forster JL, McGovern PG, Wagenaar AC, Wolfson M, Perry CL, Anstine PS. The ability of young people to purchase alcohol without age identification in northeastern Minnesota, USA. Addiction 1994; 89:699–705.
[12] Forster JL, Murray DM, Wolfson M, Wagenaar AC. Commercial availability of alcohol to young people: results of alcohol purchase attempts. Prev Med 1995;24:342–7.
[13] Grube JW. Preventing sales of alcohol to minors: results from a community trial. Addiction 1997;92(Suppl 2):S251–60.
[14] Jones-Webb R, Toomey TL, Short B, Murray DM, Wagenaar A, Wolfson M. Relationships among alcohol availability, drinking location, alcohol consumption and drinking problems in adolescents. Subst Use Misuse 1997;32:1261–85.
[15] Wagenaar AC, Finnegan JR, Wolfson M, Anstine PS, Williams CL, Perry CL. Where and how adolescents obtain alcoholic beverages. Public Health Rep 1993;108:459–64.
[16] Sussman S. Curriculum development in school-based prevention research. Health Educ Res, Theory Pract 1991;6:339–51.
[17] Hansen WB. Prevention of alcohol use and abuse. Prev Med 1994;23:683–7.
[18] Foxcroft DR. Adolescent alcohol use and misuse in the UK. Educ Child Psychol 1996;13(1):60–8.
[19] Foxcroft DR, Lister-Sharp D, Lowe G. Alcohol misuse prevention for young people: a systematic review reveals methodological concerns and lack of reliable evidence of effectiveness. Addiction 1997;92:531–7.
[20] Giesbrecht N, Grube JW. Information, education, and persuasion as strategies for reducing or preventing drinking-related problems. In: Babor T, Caetano R, Casswell S, et al., editors. Alcohol: No ordinary commodity. Melbourne: Research and Public Policy, Oxford University Press.
[21] Paglia A, Room R. Preventing substance use problems among youth: a literature review and recommendations. J Prim Prev 1999;20:3–50.
[22] Grube JW, Nygaard P. Overview of effective interventions for young people. In: Stockwell, T, Gruenewald, PJ, Toumbourou, J and Loxley W, editors. Working upstream: Drugs, science and prevention policy. New York: Wiley. (in press).
[23] Toomey TL, Wagenaar AC. Policy options for prevention: the case of alcohol. J Public Health Policy 1999;20:193–212.
[24] Wagenaar AC, Murray DM, Gehan JP, Wolfson M, Forster JL, et al. Communities mobilizing for change on alcohol: outcomes from a randomized community trial. J Stud Alcohol 2000;61:85–94.
[25] Office of Juvenile Justice and Delinquency Prevention (1999). Regulatory strategies for reducing youth access to alcohol: best practices. Calverton, MD: Office of Juvenile Justice and Delinquency Prevention, Center for Enforcing Underage Drinking Laws. Available online at: http://www.udetc.org/documents/accesslaws.pdf.
[26] Abbey A, Scott RO, Smith MJ. Physical, subjective, and social availability: their relationship to alcohol consumption in rural and urban areas. Addiction 1993;88:489–99.
[27] Treno AJ, Gruenewald PJ, Johnson FW. Alcohol availability and injury: the role of local outlet densities. Alcohol Clin Exp Res 2001;25:1467–71.
[28] Gruenewald PJ, Millar AB, Treno AJ, Yang Z, Ponicki WR, Roeper P. Geography of availability and driving after drinking. Addiction 1996;91:967–83.
[29] Freisthler B, Gruenewald PJ, Treno AJ, Lee J. Evaluating alcohol access and the alcohol environment in neighborhood areas. Alcohol Clin Exp Res 2003;27:477–84.
[30] Treno AJ, Grube JW, Martin S. Alcohol outlet density as a predictor of youth drinking and driving: a hierarchical analysis. Alcohol Clin Exp Res 2003;27:835–40.
[31] Kann L, Kinchen SA, Williams BI, Ross JG, Lowry R, Grunbaum JA, et al. Youth risk behavior surveillance—United States, 1999. Morb Mortal Wkly Rep 2000;49(SS-5):1–94.
[32] SAS Version 9.0, User Manual. Cary, NC.
[33] Hannan PJ, Murray DM. Gauss or Bernoulli? A Monte Carlo comparison of the performance of the linear mixed-model and the logistic mixed-model analyses in simulated community trials with a dichotomous outcome variable at the individual level. Eval Rev 1996;20(3): 338–52.